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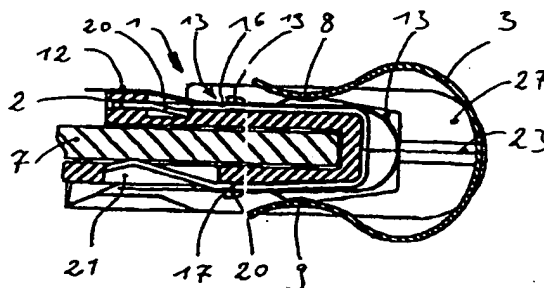
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### (54) Connector for Connecting a printed circuit board to a flat flexible circuit

(57) A connector assembly (1) for connecting rigid circuit board (7) to a flat flexible circuit (12). The connector includes a U-shaped housing (4) with a receptacle for the rigid circuit board and a receptacle for the flexible circuit. A U-shaped contact element (2) is arranged in the connector's mounted state between the flexible circuit and the circuit board. The contact element is in contact with a connecting surface of the circuit board and a connecting surface of the flexible circuit. The housing surrounds the circuit board at an edge and includes openings through which a respective contact arm of the contact element can extend to the circuit board. A compression spring (3) produces a pressing force between the flexible circuit and the contact element.

Fig. 1



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## Descripti n

### Field of the Invention

[0001] This invention generally relates to a connector for connecting a printed circuit board to a flat flexible circuit.

### Background of the Invention

[0002] In the field of electronics and specifically of motor vehicle electrical systems, there is an increasing requirement for connections between rigid printed circuit boards and flexible cables such as flat flexible circuits (or "FFCs"). Since relatively complex circuits are now constructed on flexible materials, their connection to conventional printed circuit boards has become increasingly more important.

[0003] Such connections have heretofore been effected by soldering, particularly in the case of known FFC constructions using polyimide as the flexible support material, and copper as the conductive material. Furthermore, since the conductive traces on the FFC consist of solid metal, i.e. copper, other known connection technologies, such as plug and screw contacts, can also be utilized in applications where additional mechanical stability is required.

[0004] However, other support materials are being used to an increasing extent, such as polyethylene terephthalate, and other conductive materials have been used, such as silver grains embedded in an epoxide. Although the layers of such conductive materials can have thicknesses of 5-10mm, they do not have the strength of conventional copper conductive material, which may be needed in some applications. Furthermore, these conductive materials are thermally and mechanically sensitive, and therefore different solutions may be required for their connection to printed circuits. In particular, the reliability of these connections in the automobile industry, in relation to mechanical loadability, vibration and corrosion resistance, for example is of utmost importance.

### Summary of the Invention

[0005] The subject invention, therefore, has as its object to provide a robust, and in particular vibration-insensitive and mechanically durable, connection between a printed circuit board and a flat flexible circuit in which good electrical contact is provided between the circuit board and the flexible circuit without the use of soldering or crimping.

[0006] According to the invention, a connector assembly is provided which comprises a substantially U-shaped contact element arranged between the flexible circuit and the circuit board and in contact with a connection surface of the circuit board and a connection surface of the flexible circuit. The contact element is

mounted within a housing which surrounds the circuit board at an edge thereof in a U-shape. The housing includes at least one passage through which a first arm of the contact element extends to contact the circuit board. A mechanically strong and vibration-insensitive mounting of the connector housing is provided by this arrangement, and short conductive paths between the circuit board and the flexible circuit are made possible.

[0007] The contact element is easily assembled onto the housing of the connector and is secured in position in the housing by an inwardly-directed latching tongue formed on the second arm of the contact element.

[0008] The first arm of the contact element is preloaded or prestressed and therefore contact pressure on the circuit board is independently exerted, and is therefore sufficient in many applications to effect an electrical connection without the costs associated with secondary soldering processes. By avoiding these processes, unfavorable temperature effects on the flexible circuit, such as can arise during reflow or wave soldering, are prevented, and mechanical damage which can arise in crimping or screwing for example is likewise avoided.

[0009] The connector assembly further includes a compression spring which produces a defined pressing force between the flexible circuit and the contact element. The compression spring secures the flexible circuit around the outer periphery of the U-shaped contact element such that bilateral pressing forces of the spring insure that one side of the contact element remains in contact with the flexible circuit even in the presence of mechanical vibration or impact when the impact effect exceeds the preload of the compression spring. External environmental influences such as vibrations or mechanical impacts can be effectively minimized by appropriate dimensioning of the compression spring, so that intermittencies are avoided. The contact element and the compression spring are constructed so that at least two contact points are produced between the flexible circuit and the contact element. In one embodiment, more than two contact points are produced by depressions or recesses in the contact element and by additional contact between a backside of the compression spring and the flexible circuit. Another embodiment provides more than two contact points between the flexible circuit and the contact element by means of the shape of the compression spring.

[0010] The assembly and handling of the connector are facilitated by latching the compression spring onto the housing in a preassembled position, from which the compression spring can be easily moved to its final mounted position. For this purpose, corresponding depressions associated with the spring are arranged on both sides of the connector housing.

[0011] The insertion of the flexible circuit into the housing is facilitated by a funnel-shaped insertion channel, defined by the compression spring in its preassembled position.

[0012] A securing rib is formed on the connector housing and engages a recess of the compression spring. The rib extends in the direction of movement of the compression spring from its preassembled position into its final mounted position and reduces vibration and movement of the compression spring therefore minimizing the introduction of unnecessary forces into the connector housing. The same result can be attained with a lateral recess formed in the connector housing, whereby the recess extends in the direction of movement of the compression spring and a lateral lug of the compression spring extends into the recess.

[0013] A flexible circuit strain relief may be provided by means of a tongue arranged on an arm of the contact element and which engages, in the final mounted position of the compression spring, an associated recess formed in the flexible circuit. The dimensioning of the tongue produces defined holding forces, in relation to the compression force exerted by the compression spring, greater than the mechanical forces which arise in everyday operation, but which release the flexible circuit before damage occurs.

[0014] Finally, a tongue formed on the connector housing engages associated openings in the compression spring and therefore holds the spring in its final mounted position. This arrangement is particularly useful in connectors subject to high mechanical or vibration loading, such as in knock sensors in the motor vehicle field.

[0015] Other objects, features and advantages of the invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings.

#### Brief Description of the Drawings

[0016] The invention is described in more detail herein below with reference to preferred embodiments and to the accompanying drawings, in which like reference numerals identify like elements in the figures and in which;

Fig. 1 is a cross section of a first embodiment of the connector according to the invention taken along line B-B of Fig. 6, showing the compression spring in its preassembled position;

Fig. 2 is a cross section of a first embodiment of the connector according to the invention taken along the line B-B of Fig. 6, showing the compression spring in its mounted position;

Fig. 3 is a cross section of a first embodiment of the connector according to the invention taken along the line A-A of Fig. 5, showing the compression spring in its mounted position;

Fig. 4a is a detail of the contact space of a first com-

pression spring according to the invention;

Fig. 4b is a detail of the contact surface of a second compression spring according to the invention, showing two contact regions;

Fig. 5 is a top view of a connector housing of the invention without the compression spring;

Fig. 6 is a view of a second connector housing of the invention showing vibration-suppressing devices, without the compression spring and without the flexible circuit;

Fig. 7 is a top plan view of a connector according to the invention mounted on a circuit board and including a flexible circuit mounted in the connector;

Fig. 8 is a cross section of a further embodiment of a connector according to the invention showing a non-metallic compression spring arranged in its preassembled position; and

Fig. 9 is a cross section of the connector of Fig. 8 showing the metallic compression spring arranged in its mounted position.

#### Detailed Description of the Preferred Embodiment

[0017] Referring first to Figure 1 in conjunction with Figure 6, a first embodiment of the invention is illustrated by an electrical connector assembly 1 adapted to effect an electrical connection between a printed circuit board 7 and a flat flexible circuit 12 ("FFC"). The connector includes a substantially U-shaped contact element 2, a substantially U-shaped compression spring 3 and a substantially U-shaped housing 4. The housing includes a plurality of cavities 5 which extend substantially parallel and open toward an exterior of the housing. A plurality of ribs 6 extend slightly beyond the floor of cavities 5 and are positioned between the cavities.

[0018] The compression spring 3 is adapted to be mounted onto housing 4 and is located within each cavity 5 between two guide ribs 27 (Fig. 5) extending from the ends of housing 4. Compression spring 3 includes pressing surfaces 8 and 9 located initially in a preassembled position of the compression spring in depressions 10 and 11 (Fig. 7), respectively, such that a funnel-shaped insertion channel, greater than the thickness of flexible circuit 12, results between the compression spring and contact element 2 to facilitate insertion of the FFC into a receptacle area 13 in the housing. Receptacle 13 surrounds contact element 2 and is configured in a U-shaped channel to guide the flex circuit during insertion into the connector.

[0019] When compression spring 3 is moved from its preassembled position (Figure 1) to a final mounted position (Figure 2), pressing surfaces 8 and 9 slide out

of depressions 10 and 11 over a slightly raised area and into depressions 14 and 15 where the pressing surfaces exert a force on the backside of the flexible circuit such that mechanical and electrical contact is effected between contact surfaces 16 and 17 of flexible circuit 12 and contact element 2. These pressing forces, produced by the arms of compression spring 3, insure at least a one-sided contact between flexible circuit 12 and contact element 2.

[0020] Compression spring 3, shown in Figure 7, may be constructed of one-piece spring which has a substantially "omega" shape in cross-section. The spring is seated in its preassembled position in depressions 10 and 11 and the spring is subsequently moved into its final mounted state into depressions 4 and 15, shown in Fig. 2. One embodiment of the connector may include depressions 10 and 11, and 14 and 15 of housing 4 arranged laterally of cavities 5 (Figure 5). Compression spring 3 may, alternatively, include many slotted arms which respectively enter each cavity 5. These arms would be similarly displaced from their preassembled position in depressions 10 and 11 into the final mounted position in depressions 14 and 15. For reasons of stability, compression spring 3 can be slotted in the region of one leg and can be formed without slots on its opposite side.

[0021] In the final mounted state of compression spring 3, strain relief tongues 19 and 20 may extend through corresponding apertures of flexible circuit 12 to provide a strain relief for the flexible circuit. The compression spring may also include corresponding apertures into which tongues 19 and 20 extend in the mounted state (see Figures 1 and 2). Tongues 19 and 20 may be formed as a portion of housing 4 or as lateral tabs formed on contact elements 2.

[0022] Contact element 2 includes a latching tongue or latching element 20 on a first arm thereof which latches into an associated opening of housing 4 when contact element 2 is arranged in its final mounted state on the housing (Figure 1). In this position, the second arm of contact element 2 extends into an opening 21 of housing 4, and electrical contact occurs between contact element 2 and a contact surface 22 of circuit board 7. In many applications, the mechanical pressing of contact element 2 against circuit board 7 provides sufficient electrical and mechanical connection between contact element 2 and circuit board 7. However, in some applications, a solder connection or other known connecting method may be applied to contact element 2 to supplement the mechanical connection, such as screwing, conductive adhesives, crimping, or other method that produces an even more reliable electrical contact in applications where the mechanical pressing alone is insufficient.

[0023] Turning now to the assembly and guidance of the compression spring on the housing, housing 4 includes lateral depressions or projections 23 (Figures 5 and 6) arranged on two guide ribs 27 which guide the

spring into its final mounted position. Ribs 27 extend outwardly from ends of housing 4, and include elements 23 on an inner side thereof extending in the direction of displacement of compression spring 3. The compression spring may include laterally projecting lugs which engage in and are guided by elongate openings 23 (Figure 6) arranged along the direction of displacement of compression spring 3. Alternatively, the compression spring may include openings which are engaged by the projections 23. Unwanted movements of spring 3 relative to depressions 14 and 15 are thereby minimized, even under relatively high forces.

[0024] Looking now to Figure 3, contact element 2 can include, instead of or in addition to latching tongue 20, a V-shaped section 24 which penetrates into opening 21 of housing 4. The V-shaped region of contact element 2 allows the flexible circuit to be brought into contact by compression spring 3 in at least two contact areas, and with further contact between pressing surface 9 and flexible circuit 12, three contact areas are effected between flexible circuit 12 and contact element 2.

[0025] Figure 4b shows a further embodiment of the invention, wherein a multiple pressing surface 25 is used, in contrast to the single pressing surfaces 8 and 9 shown in Fig. 4a. A double contact between flexible circuit 12 and contact element 2 occurs in at least two areas by means of the double shoulder of pressing surface 25.

[0026] A cross-sectional view of still a further embodiment according to the invention is shown in Figs. 8 and 9. Contact elements 2 are shown extending outwardly on each side and are made of a resiliently elastic material. A U-shaped slide 28, preferably consisting of plastic, is provided in place of compression spring 3 and includes elements 29 extending laterally from its ends. In this embodiment, housing 4 includes a lateral aperture 30 which has an inside width dimension that corresponds to the dimension of the outer surface of latch elements 29. Instead of depressions 10 and 11, latches 31 and 32 are provided on the inner side of opening 30, and latch element 29 engage behind them when slide 28 is inserted into the housing. Further latches 33 and 34 are formed on inner side of aperture 30 and define the final mounted position of slide 30, wherein latches 33 and 34 engage latch elements 29 such that a flexible circuit arranged between slide 28 and contact element 2 is reliably pressed against and makes contact with contact element 2.

[0027] As shown in Fig. 9, stops 35 and 36 may be provided which limit the movement of slide 28 in the insertion direction of its final mounted position.

[0028] Furthermore, this embodiment includes contact elements 2 having V-shaped latch elements 37 and 38 which latch in openings 21 of housing 4 when the contact element is pushed into the housing.

[0029] Although it has been assumed in the preceding description that flexible circuit 12 has contact surfaces 16 and 17 on a single side, the flexible circuit can

include contact surfaces on both sides, and can include, for example, conductive surfaces on its backside, i.e., the side remote from contact element 2, connected by compression spring 3 as ground contacts to minimize electrostatic discharges, for example, in the field of sensors for air bags, or in order to provide additional screening.

[0030] Furthermore, certain of the compression springs 3 of the backside contact surfaces of flexible circuit 12 may be electrically coupled in order to electrically sense the correct positioning of compression spring 3, to offer additional security for important circuits or to be able to detect erroneous functioning with on-board testing systems of, for example, motor vehicles.

[0031] It will be understood that the invention may be embodied in other specific forms without departing from the spirit or central characteristics thereof. The present examples and embodiments, therefore, are to be considered in all respects as illustrative and not restrictive, and the invention is not to be limited to the details given herein.

#### Claims

1. A connector assembly (1) for effecting a connection between a printed circuit board (7) and a flat flexible cable (12) comprising:
  - a substantially U-shaped housing (4) for receiving the printed circuit board;
  - a substantially U-shaped contact element (2) mounted in the housing; and
  - a substantially U-shaped compression spring (3) including pressing surfaces for pressing the flat flexible cable into contact with the contact element, wherein the compression spring is movable between a preassembled position whereat the pressing surfaces (8, 9) are located in first depressions (10, 11) of the housing and a final mounted position whereat the pressing surfaces (8, 9) are located in second depressions (14, 15) of the housing.
2. The connector assembly as set forth in claim 1, wherein the housing (4) includes an opening (21) through which an arm of the contact element extends.
3. The connector assembly as set forth in claim 1, wherein the contact element (2) includes a latching element (20) on one arm thereof which latches into an associated opening of the housing (4) to secure the contact element within the housing.
4. The connector assembly as set forth in claim 1, wherein the preassembled position of the compression

sion spring defines a funnel-shaped insertion channel to facilitate insertion of the flexible circuit into the connector housing (4).

5. The connector assembly as set forth in claim 1 further including strain relief means (19, 20) which extend through apertures of flexible circuit 12 to provide strain relief for the flexible circuit.

Fig. 1

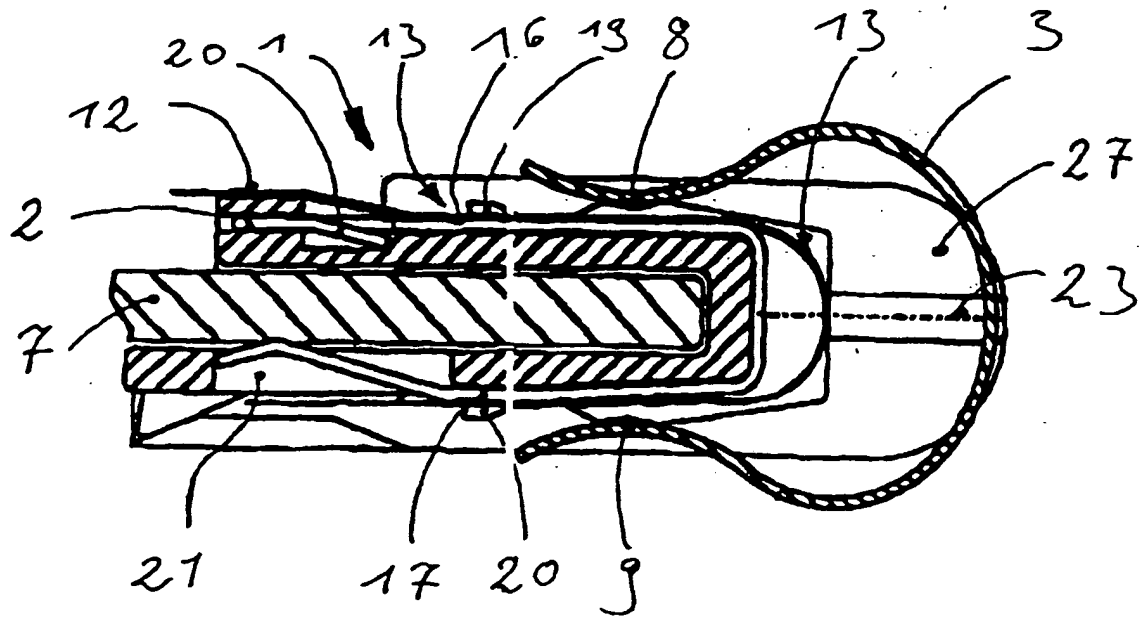
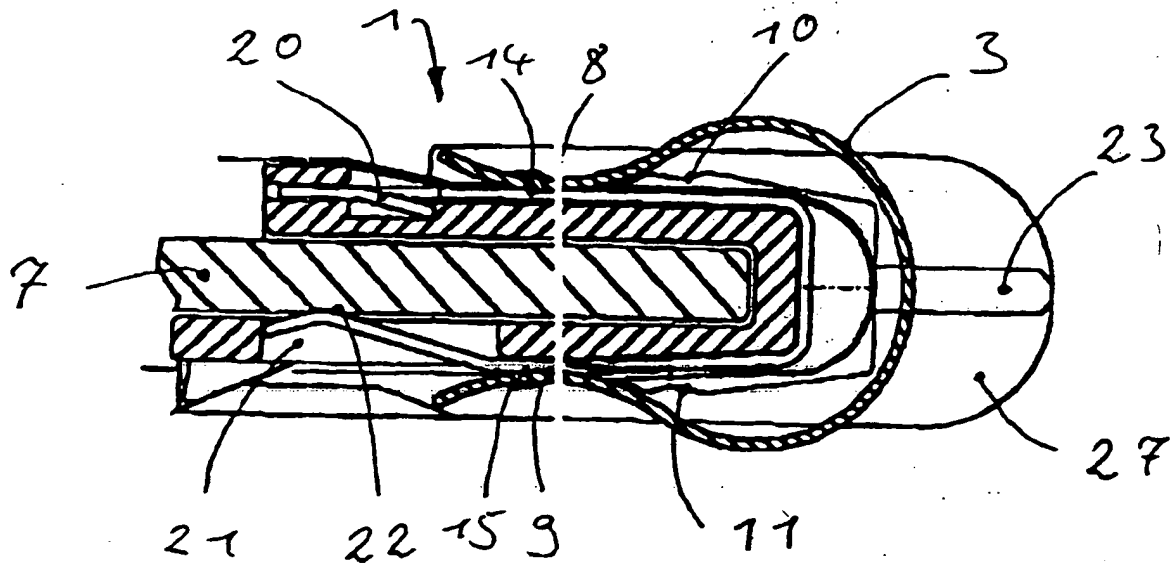


Fig. 2



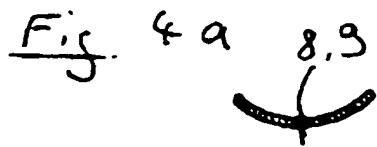
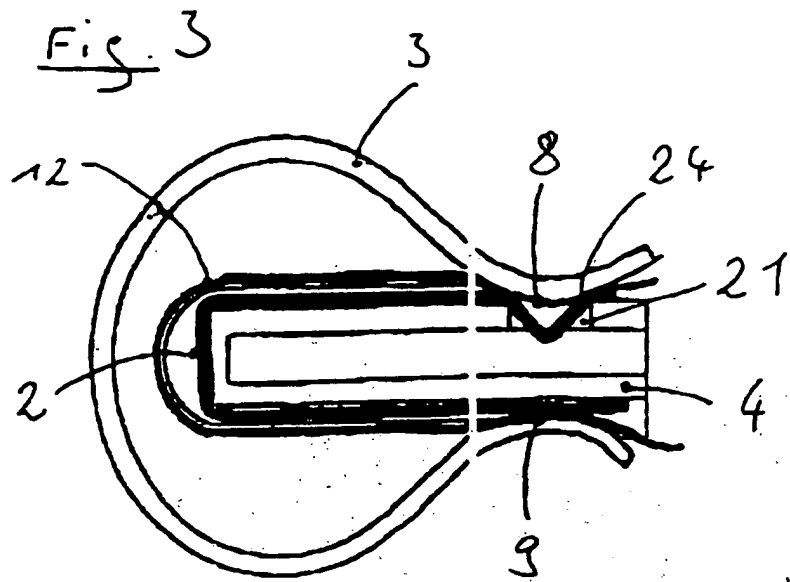


Fig. 4b

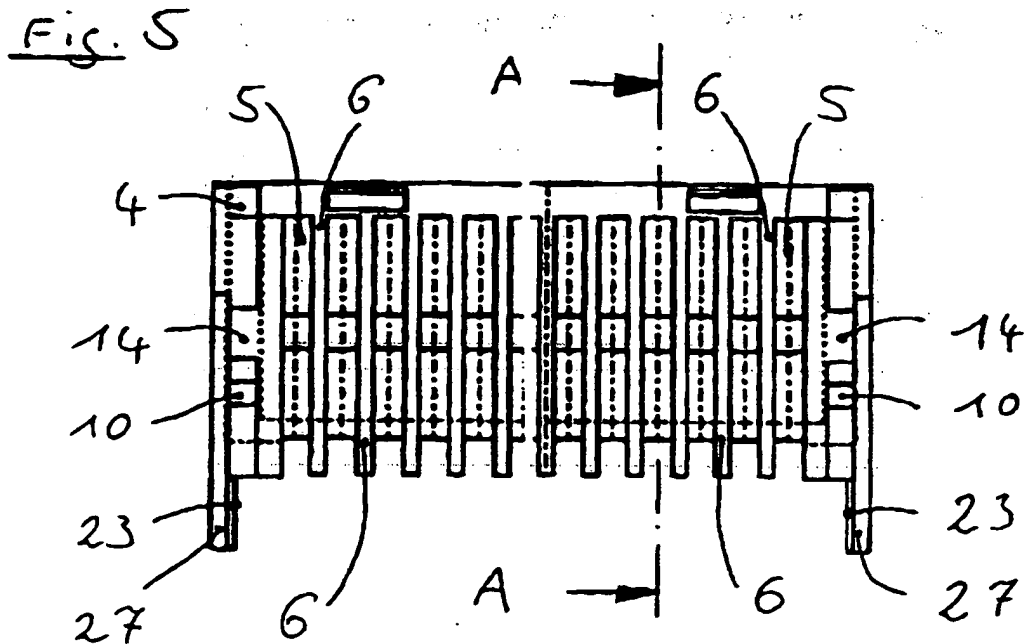


Fig. 6

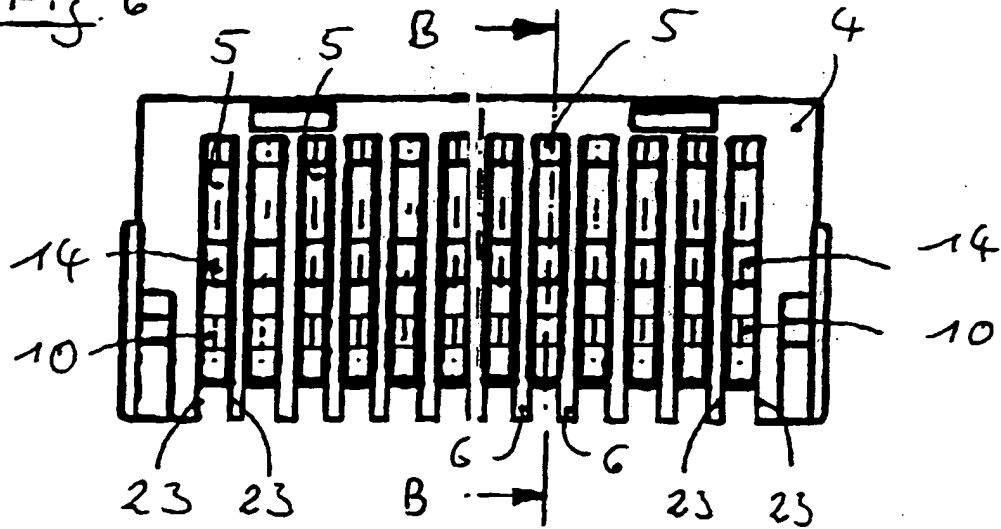
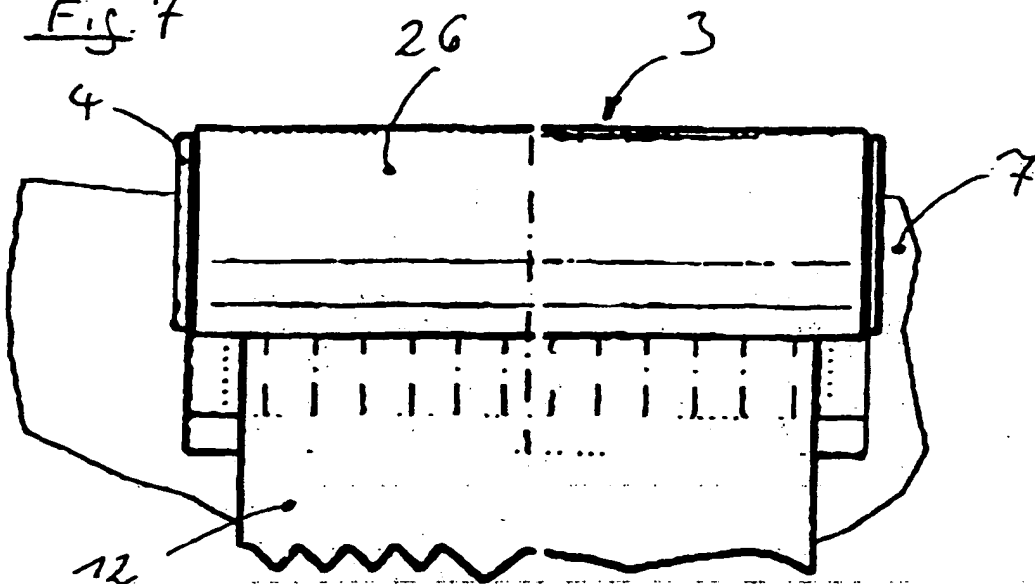


Fig. 7







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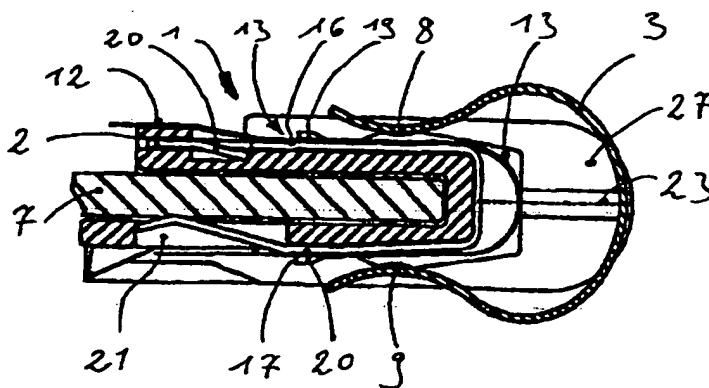
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## (54) Connector for Connecting a printed circuit board to a flat flexible circuit

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Fig. 1



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# EUROPEAN SEARCH REPORT

Application Number  
EP 98 11 4737

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
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Y	US 3 319 216 A (R.W. MCCULLOUGH) 9 May 1967 (1967-05-09) * column 1, line 48 - column 2, line 24 * * figures 1-3 *	1-4	
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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			H01R
Place of search	Date of completion of the search	Examiner	
BERLIN	29 July 1999	Stirn, J-P	
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